

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
30 August 2001 (30.08.2001)

PCT

(10) International Publication Number
WO 01/62539 A1

(51) International Patent Classification⁷: **B60N 2/00**

(21) International Application Number: **PCT/US01/06003**

(22) International Filing Date: 23 February 2001 (23.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/184,947 25 February 2000 (25.02.2000) US

(71) Applicant: **SIEMENS AUTOMOTIVE CORPORATION** [US/US]; 2400 Executive Hills Boulevard, Auburn Hills, MI 48326-2980 (US).

(72) Inventors: **COOK, Charles, R., Jr.**; 2800 River Trail, Rochester MI 48309 (US). **REICH, Daniel**; 15642 Lorway, Clinton Township, MI 48038 (US). **MORELL, Scott**; 4594 Spring Drive, White Lake Twp., MI 48303 (US). **BELAU, Horst**; Gabriele Muentner Weg 2, 84085

Langquaid (DE). **SWART, Marten**; Albrecht-Altdorfer-Ring 7a, 93083 Obertraubling (DE). **LICHTINGER, Harald**; Beacon Hill Court, Apt. 308, Auburn Hills, MI 48326 (US).

(74) Agents: **SLENZAK, Laura**; c/o Keller, Elsa, Siemens Corporation, 186 Wood Avenue South, Iselin, NJ 08830 et al. (US).

(81) Designated States (*national*): JP, KR.

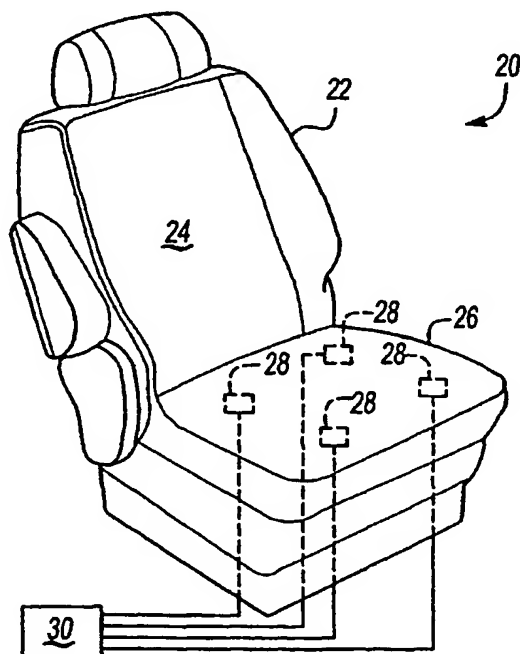
(84) Designated States (*regional*): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **SIGNAL PROCESSING IN A VEHICLE WEIGHT CLASSIFICATION SYSTEM**



(57) Abstract: A vehicle weight classification system (20) recognizes the various factors that influence system performance. Some of the factors are compensated for using analog signal processing circuitry or techniques. Other factors are compensated for using digital signal processing techniques. The unique combination of analog and digital approaches, rather than pure analog or pure digital, provides an effective solution at addressing the various factors that influence signals and system performance in a vehicle weight classification system while keeping the cost and complexity of the system within acceptable limits.

WO 01/62539 A1

SIGNAL PROCESSING IN A VEHICLE WEIGHT CLASSIFICATION SYSTEM

BACKGROUND OF THE INVENTION

5 In general terms, this invention relates to vehicle weight classification systems for classifying the weight of an occupant on a vehicle seat. More particularly, this invention relates to a signal processing system and method for handling sensor signals used in a vehicle weight classification system.

10 Contemporary vehicles typically include safety restraints to protect passengers and drivers during impact. Such restraints include seatbelts and airbags, for example. It has recently become apparent that customized control of airbags is desirable. The owner of this application has developed a weight classification system that is useful for determining the size or weight of a seat occupant and controlling an airbag deployment responsive to that determination.

15 One of the challenges in designing a weight classification system is keeping the system simple and robust. In order to do so, choices must be made regarding the types of components utilized as sensors and signal processing, for example. There are competing concerns between system performance (i.e., accuracy), cost and durability of the system components. These various factors present complicating and sometimes competing interests for designing such a system.

20 In addition to the system constraints, there are a variety of factors that must be accounted for when operating a weight classification system. Certain factors affect the performance of the system. Such factors include for example, temperature, sensor offset, signal strengths and the capabilities of the various components used in the system. There is a need for a way of addressing the various issues that must be compensated for when operating a weight classification system.

25 This invention provides a unique approach to addressing the various influences on the operation of a weight classification system.

SUMMARY OF THE INVENTION

30

 In general terms, this invention is a system for compensating for various factors that influence the operation of a vehicle weight classification system. This

invention includes the identification of various factors that must be compensated for in handling signals in a weight classification system. Some of these factors are compensated for using analog signal processing techniques. Other factors are compensated for using digital signal processing techniques. The combination of
5 analog and digital approaches provides a solution that adequately addresses the various and different concerns raised when operating a weight classification system while keeping the system cost and complexity within acceptable limits.

The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently
10 preferred embodiments. The drawings that accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 diagrammatically illustrates a weight classification system designed
15 according to this invention.

Figure 2 schematically illustrates a portion of the system of Figure 1.

Figure 3 schematically illustrates a circuit designed according to this invention.

Figure 4 schematically illustrates further details regarding selected portions
20 of the embodiment of Figure 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A vehicle weight classification system 20 is used for determining the weight of an occupant of a seat 22 in a vehicle. The seat includes a seat back 24 and a seat
25 base 26. A plurality of sensor assemblies 28 preferably are supported relative to the seat base 26 so that the weight of a seat occupant can be determined. Each of the sensor assemblies 28 preferably communicates with a supplemental restraint controller 30, which is an airbag firing controller in one example.

Each of the sensor assemblies 28 preferably includes a sensor 32 that
30 generates an electrical signal indicative of the weight of the seat occupant. In one example, the sensors 32 are strain gauge sensors. Because strain gauge sensors are used as an example, some of the factors affecting the operation of the weight

classification system that are described in this specification are those typically encountered when using a strain gauge sensor, such as offset calibration.

Each sensor assembly 28 preferably includes a signal conditioning portion 34 that addresses the various factors that affect the operation of the system or the effectiveness of the sensor signal.

Part of this invention is identifying the various factors that must be addressed to insure the best possible system operation. These factors include sensor offset, sensor temperature correction, circuitry offset, circuitry temperature correction, seat parameters, vehicle parameters, and spread in the sensor signal strength. These are example factors that affect the operation of the system and that are preferably compensated for in a system designed according to this invention. Not all of these factors must be accounted for in all situations. It is preferred to identify those which have the greatest impact on the system operation and address those most effectively while possibly addressing the others depending on the needs of a particular situation. Those skilled in the art who have the benefit of this description will be able to determine what factors must be accounted for in their own situation. The approach of this invention may be applied in a variety of circumstances to address a variety of factors that must be compensated for.

One example signal conditioning module 34 is shown in Figure 3 as an integrated circuit chip. An example, commercially available such chip is known as the MAX1452 chip available from Maxim.

The signal conditioning module 34 preferably includes a microcontroller 36 that communicates with a temperature compensation module 38 and an offset calibration module 40. Temperature compensation and offset calibration are used as examples because they are two of the primary factors affecting system performance.

In the illustrated example the temperature compensation module 38 and the offset calibration module 40 preferably are analog signal processing portions. The microcontroller 36 preferably obtains information from the signals provided by the temperature compensation module 38 and the offset calibration module 40 to make a determination on how to calibrate the system or compensate for influences on the received signals from the sensors 32. A memory portion 42 preferably includes a variety of data that enables the micro controller 36 to make temperature corrections

or sensor offset corrections, for example. Those skilled in the art who have the benefit of this description will be able to determine the types of information to be stored in such memory so that the micro controller 36 can make appropriate determinations and corrections to the sensor signals. The micro controller 36
5 preferably communicates through a serial interface 44 to provide a digitized output 46 to the supplemental restraint controller 30.

The signals from the sensors 32 preferably are propagated through an H bridge arrangement as shown in Figure 3. In this example the bridge signal preferably is amplified and ultimately digitized to a pulse width modulated signal for
10 transmission to the supplemental restraint controller 30. As seen in Figure 4, an instrumentation amplifier provides amplification while a pulse width modulation converter provides digitization.

In addition to amplification, the strain gauge signal in the illustrated example preferably is calibrated for 2.5 volt mid scale offset, using a zero weight reference
15 point. The strain gauge signal preferably is also compensated for a strain gauge bridge no-load offset shift over temperature. In addition, an analog switch for auto-zero cycle to correct for shifts and amplifier offset voltage due to temperature variations and over time drift preferably is included. In the illustrated example, the zero signal causes an internal solid state switch to short out instrumentation
20 amplifier inputs.

In the illustrated example, an oscillator signal generator 50, which preferably is a saw tooth generator, provides for digitization of the analog sensor output signal. In the preferred embodiment, pulse width modulation is used to provide a digitized pulse width modulated output at 52, which is fed to the controller 30. An example
25 implementation of pulse width modulation for this purpose is described in United States Patent Application No. 09/651,714 which was filed on August 31, 2000. The teachings of that application are incorporated into this specification by reference. Utilizing the pulse width modulation technique provides a digitized output that is superior to a simple analog to digital conversion. The typical microcontroller used
30 within a weight classification system does not have adequate resolution to accurately make a weight determination based upon simply converting the analog sensor signal to a digital format.

5 This invention provides a way of compensating for one or more factors affecting the sensor output using analog circuitry techniques. The examples in the illustrated circuitry include temperature compensation and offset calibration. Other factors, such as signal strength, which is typically very small from a strain gauge signal, are handled using digital circuitry techniques by digitizing the output. Using a combination approach (i.e., some analog, some digital) provides the ability to adequately compensate for the various factors affecting system performance. A purely digital approach or purely analog approach is inferior to the unique, combined approach of this invention.

10 The preceding description is exemplary rather than limiting in nature. Variations and modifications may become apparent to those skilled in the art that do not necessarily depart from the pursue or spirit of this invention. The scope of legal protection given to this invention can only be determined by studying the following claims.

15

CLAIMS

We claim:

1. A method of compensating for various influences on a sensor signal that provides an indication of a weight of a seat occupant in a vehicle supplemental
5 restraint system, comprising the steps of:
 - (A) identifying a plurality of factors that influence the sensor signal;
 - (B) processing the signal using analog signal processing to compensate for at least one of the factors; and
 - (C) processing the signal using digital signal processing to compensate
10 for at least one other of the factors.
2. The method of claim 1, wherein the factors include temperature, sensor offset, signal strength, signal spread, and vehicle seat parameters.
- 15 3. The method of claim 2, including compensating for the temperature factor using the analog signal processing.
4. The method of claim 2, including compensating for the sensor offset factor using the analog signal processing.
20
5. The method of claim 2, including compensating for the signal strength using the digital signal processing.
6. A vehicle weight classification system, comprising:
25 a plurality of sensors that provide an electrical signal indicative of the weight of a seat occupant;
a signal conditioner associated with each sensor having a first portion that utilizes an analog signal to compensate for at least one factor that influences the sensor signal and a second portion that utilizes a digital signal to compensate for at
30 least one other factor that influences the sensor signal; and
a controller that receives the conditioned signal and controls a supplemental restraint device.

7. The system of claim 6, wherein the signal conditioning module first portion compensates for temperature influences on the sensor signal.

8. The system of claim 6, wherein the signal conditioning module first
5 portion compensates for sensor offset factors.

9. The system of claim 6, wherein the signal conditioner second portion compensates for signal strength.

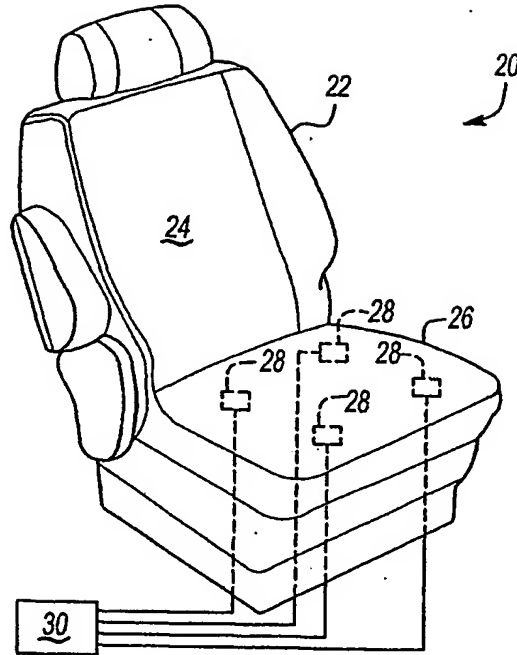


Fig-1

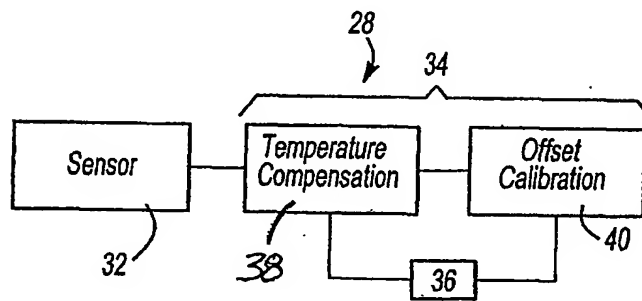
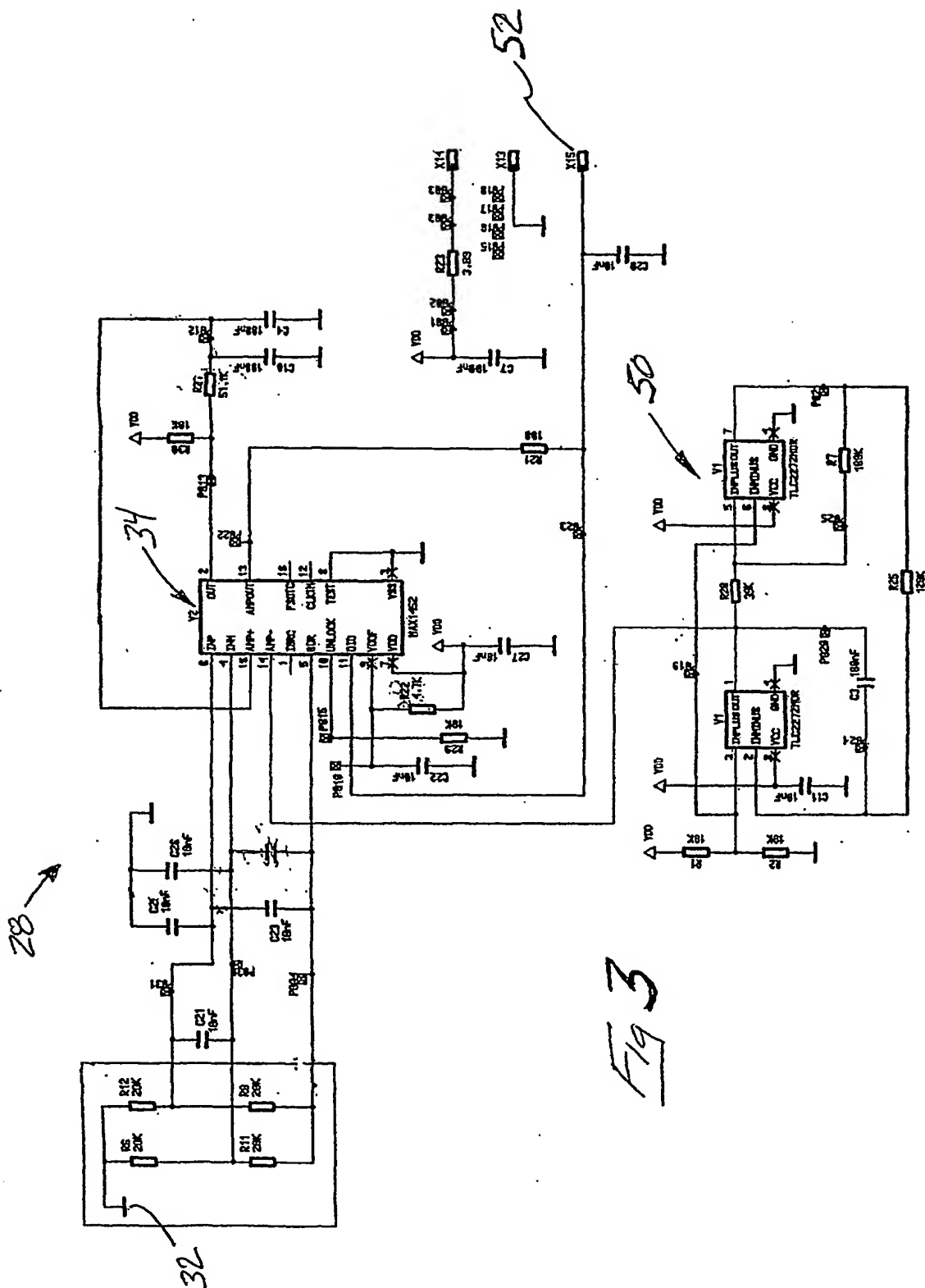


Fig-2



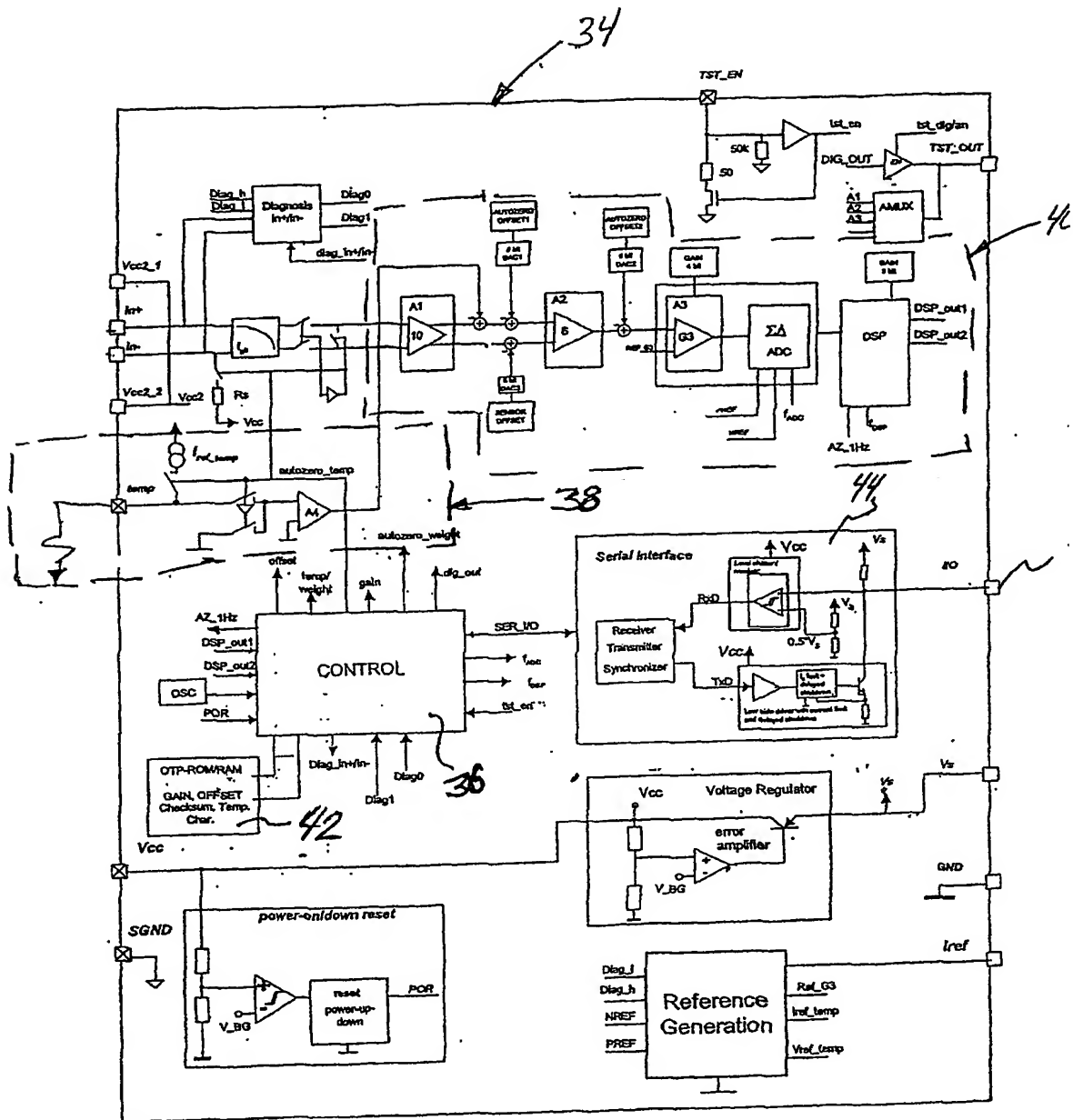


Fig 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/06003

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 B60N2/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 B60N		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99 24285 A (SIEMENS AUTOMOTIVE CORP LP) 20 May 1999 (1999-05-20) the whole document	1,6
A	WO 98 49031 A (AUTOMOTIVE SYSTEMS LAB) 5 November 1998 (1998-11-05)	
A	DE 197 54 166 A (VOLKSWAGENWERK AG) 10 June 1999 (1999-06-10)	
<input type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
* Special categories of cited documents : *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the International filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the International filing date but later than the priority date claimed *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *&* document member of the same patent family		
Date of the actual completion of the international search 5 July 2001		Date of mailing of the international search report 12/07/2001
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl. Fax: (+31-70) 340-3016		Authorized officer Horváth, R

INTERNATIONAL SEARCH REPORT

Information on patent family members

National Application No

PCT/US 01/06003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9924285 A	20-05-1999	AU 1402599 A	31-05-1999
		EP 1028867 A	23-08-2000
		US 6070115 A	30-05-2000
		US 6243634 B	05-06-2001
WO 9849031 A	05-11-1998	EP 0977679 A	09-02-2000
DE 19754166 A	10-06-1999	NONE	